An Approach towards an Energy Efficient, Green Mediterranean City in Alexandria, Egypt

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ABSTRACT: The rise in the level of global warming in the world has lead to climate change and in the weather patterns and rise of diseases in the world. These changes started to lead us into a new era, an era of renewable energy and sustainability. This study is part of continuing research work carried out by the researchers at the EDRG (Environmental Design Research Group) in Alexandria, Egypt on the use of renewable energy sources in Egypt. The work presented in this paper is a preliminary study conducted out by the EDRG in the field of renewable energy and more work is being done on it. The paper discusses briefly what is global warming and climate change and how they affect us today. The Mediterranean is particularly threatened by climate change (increasing water stress, desertification, droughts and flooding, submergence of low-lying delta areas, etc.) and the Kyoto Protocol represents an opportunity for funding development. Rational energy use and increasing use of clean and renewable energies (solar, wind, biomass, etc.) is the most important energy stakes facing the region. Analysis of Alexandria's existing waterfronts will take place and start to allocate all the water resources on these waterfronts. The alternative use of renewable energy technologies for a sustainable future will be discussed. A conclusion will later be derived and from comes the recommendations.

Keywords: Renewable energy; global warming, climate change; tidal power, wave power, offshore wind turbine; hydro-electric power

1.INTRODUCTION

The natural system known as the "greenhouse effect" regulates the temperature on earth. Human activities have the potential to disrupt the balance of this system. As human societies adopt increasingly sophisticated and mechanized lifestyles, the amounts of heat-trapping gases in the atmosphere have been increased. By increasing the amount of these gases, humankind has enhanced the warming capability of the natural greenhouse effect. It is the human-induced enhanced greenhouse effect that causes environmental concern. It has the potential to warm the planet at a rate that has never been experienced in human history. This intensifies the natural greenhouse effect causing Global Warming or Climate Change. Global warming of just a few degrees would represent an enormous change in climate.

Climate change is a change in the "average weather" that a given region experiences. Average weather includes all the features we associate with the weather such as temperature, wind patterns and

precipitation. When we speak of climate change on a global scale, we are referring to changes in the climate of the *Earth as a whole*. The rate and magnitude of global climate changes over the long term have many implications for natural ecosystems.

An increase in global temperatures can in turn cause other changes, including;

- A rise in the sea level and changes in the amount and pattern of precipitation. These changes may increase the frequency and intensity of extreme weather events, such as floods, droughts, heat waves, hurricanes, and tornados [1].
- Higher or lower agricultural yields, glacier retreat, reduced summer stream flows, species extinctions and increases in the ranges of disease vectors [2].

Warming is expected to affect the number and magnitude of these events; however, it is difficult to connect particular events to global warming. Although most studies focus on the period up to 2100, warming (and sea level rise) is expected to continue past then, since CO2 has a long average atmospheric lifetime [1].

Coastal wetlands have been able to keep pace with a sea level rise of approximately 1 millimeter (mm, about 0.04 inches) per year for the past 3,000 years. However, global average sea levels will rise by around 6 mm per year for the next century [3], which may ultimately drown these wetlands as well as erode and submerge many of the beaches, coastal communities and small islands.

Global warming could raise sea levels approximately 1/2 to 1 meter by the year 2100 [3] by expanding ocean water, melting mountain glaciers, and causing ice sheets in Greenland to melt or slide in the ocean.

At the 12th Conference of the Contracting Parties to the Barcelona Convention (Monaco, November 2001) the riparian Mediterranean countries and the European Community decided to prepare a 'Mediterranean Strategy for Sustainable Development' and requested the development of a draft [4]. They assured the importance of the turn of Mediterranean cities to sustainable clean technologies.

The provision of electricity and energy is considered a precondition and natural requisite for any human being to pursue his or her life. On one hand it is a basic demand for any country seeking to achieve economic, social and cultural development, because without access to energy no state can acquire its desired development. On the other hand, escalating petroleum and gas prices prompts us to search for alternatives. These alternative renewable energy sources may prove expensive at present, but will be necessary and indispensable alternatives as time passes, since traditional energy sources will soon be depleted. Renewable energy is accepted as a key source for the future, not only for Egypt, but also for the world [5].

Continuing to produce traditional energy will inevitably result in surging global temperatures to hazardous levels by 2100 [6], posing a particular threat to the poor, since the wealthy can adapt to climatic changes or at worst relocate to a new area. But today we are confronted with the problem of growing number of refugees fleeing climatic changes, and others leaving their countries in search of drinking water and electricity sources, which surmount refugees displaced by wars or armed conflicts.

2.APPLICATION OF RENEWABLE ENERGY IN EGYPT

Egypt is one of the first countries that have signed the Kyoto protocol in the Middle East. NREA (New and Renewable Energy Authority) established in 1986 ambitiously aimed at supplying 3% of Egypt's electric energy demand in 2010 using renewable energy, on its establishment in 1986 [2]. We are now three years away from this aim, and the percentage of electricity produced by renewable energy is still a fraction of this figure. However, a new figure has been

published; the NREA now aims to supply 14% of Egypt's electricity by renewable energy by the tear 2020. Egypt has some implemented projects in Hurghada, Kuraymat, Zaafarana, Borg El-Arab, Ras Gharib and Others [7]. In this paper we discuss the potentials on the Mediterranean coast and the alternative sources of Energy that can be implemented on it.

2.1 Alexandria's History and Potentials

Alexandria is one of the countries that face the dangers of global warming with the adverse change in weather patterns and it's at risk of sinking under the level of water. Alexandria, the second largest city in Egypt, extends 32km along the Mediterranean coastline, and is the primary seaport of the country [8]. However, its roots go a long way back to prehistoric times, when Alexandria was originally a small fishing village named Rakotis, before Alexander the Great conquered the city in B.C 332 [9]. Alexander than turned Alexandria into a typically-designed linear Greek city with similar attributes to that of cities found on the mainland [10] as shown in Fig.1.

Figure 1: Photo depict the Hepastatadion Mainland Development during Modern Times

For many years Alexandria's main source of income was from the water front however over the years the importance of this role has fallen dramatically and instead is used as a place to discharge waste products and pollution. Alexandria has 3 main water fronts; Mediterranean Sea, Mahmoudeya Canal and Maryout Lake.

All these waterfronts have their own potentials and constraints. Unfortunately these days part of these waterfronts is dramatically used for factories and slum areas for people to live in. The factories in these areas produce large amounts of pollution which is a great leader to global warming and the green house effect.

Today, there are many different sources of renewable energy technologies the ones that are governed by water are the ones to be discussed in this paper. The paper explores other solutions to the use of water energy in Alexandria and means to benefit from it. This leads to the reduction of the use of non-renewable energy resources in Alexandria and its Movement into the renewable energy Era.

As Alexandria has already been facing some of the irregular weather patterns, then a reduce in the green house gases emitted should be taken into consideration.

3. RENEWABLE ENERGY SOURCES GOVERNED BY WATER

3.1. Wave Power

Ocean waves are caused by the wind as it blows across the sea. Waves are a powerful source of energy. The problem is that it's not easy to harness this energy and convert it into electricity in large amounts. Thus, wave power stations are rare. Waves, particularly those of large amplitude, contain large amounts of energy. Wave energy is in effect a stored and concentrated form of solar energy, since the winds that produce waves are caused by pressure differences in the atmosphere arising from solar heating.

Advantages; Wave power once constructed, running costs are very low. There is no waste or pollution produced of its usage. Wave-energy generators can produce large amounts of energy.

Disadvantages; Wave-energy generators are only effective where they are exposed to strong waves. They can be noisy unless a silencer is fitted to the turbine.

Figure 2 Pelamis offshore wave energy in Portugal (3)

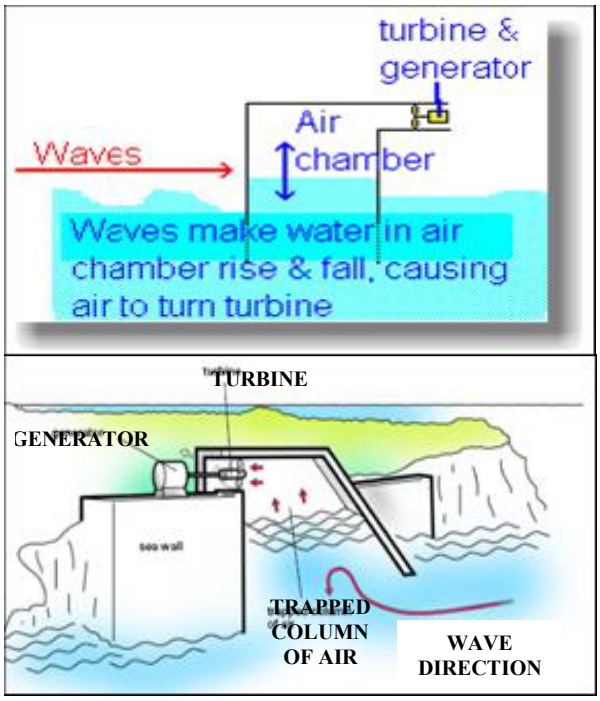

Figure 3 depicts a diagram of the mechanism of wave power

3.2 Tidal Power

In a barrage scheme, a bay or inlet is dammed with gates and turbines fitted along the length of the dam. The gates are opened to allow the tide to flow in, and turn the turbines, which turns the generators to produce electricity shown in Fig. 4.

Figure 4 shows the gates that allows tidal power

Advantages; Tidal power running costs are very low. No waste or pollution is produced. This technology is very reliable and requires no fuel. The amount of electricity and the time it is produced is totally predictable and can be easily calculated. Tidal energy barrages would modify existing estuarine ecosystems to varying degrees [11].

Disadvantages; There are only a few suitable places for tidal energy projects. Tidal stream technology is at a very early stage of development and is largely used in Denmark. Tidal schemes are expensive to install compared with other renewable energies but once installed are cheap to maintain as mentioned. Damming bays or inlets can affect the environment over a large area. Barrage schemes will only provide energy for about 10 hours each day, as the tide moves in and out.

3.3 Hydro Power

Hydropower is today the most important kind of renewable and sustainable energy [5]. Water is pumped up to the top reservoir at night, when demand for power across the country is low. When there's a sudden demand for power, the "head gates" (huge taps) are opened, and water rushes down the tunnels to drive the turbines, which drive the powerful generators. The water then collects in the bottom reservoir, ready to be pumped back up later [12].

Figure 5: shows water being released under pressure, after it has turned the turbines inside the dam to generate electricity (Laggan Dam).

Advantages; Once construction is completed, operating costs are very low. No waste or pollution is produced. This technology is very reliable. The water can be stored behind the dam to deal with peaks in demand. Power output can be increased very quickly to meet sudden demand. Electricity can be generated constantly.

Disadvantages; Dams are very expensive to build. Large-scale flooding may cause environmental problems. Suitable sites for their erection are limited. Hydro-power sites are often remote; this leads to higher distribution costs.

3.4 Off Shore Wind Farms

The force of the wind spins a large propeller (rotor). The propeller is connected to a generator. When the wire coils are spun quickly inside the magnets, they produce electricity [13].

Figure 6: shows wind farms in Denmark

The best places for wind farms are in coastal areas, at the tops of rounded hills, open plains and gaps in mountains [13] - places where the wind is strong and reliable.

Advantages; once the wind turbine is constructed, running costs are very low. No waste or pollution is produced. The land occupied by a wind farm can still be used for farming. Wind farms can become tourist attractions.

Disadvantages; no wind, no power. Some people object because they feel wind farms spoil the view. Wind farms create a constant low-level noise. They can interfere with television reception and radar.

4. RENEWABLE ENERGY PROPOSED TO BE USED ON ALEXANDRIA'S WATERFRONT

As mentioned earlier Alexandria has a huge waterfront with a lot of potential; High waves, unused areas, strong wind movements, strong currents. In this paper 2 of these waterfronts will be discussed the Mediterranean sea and the Mahmoudeya canal.

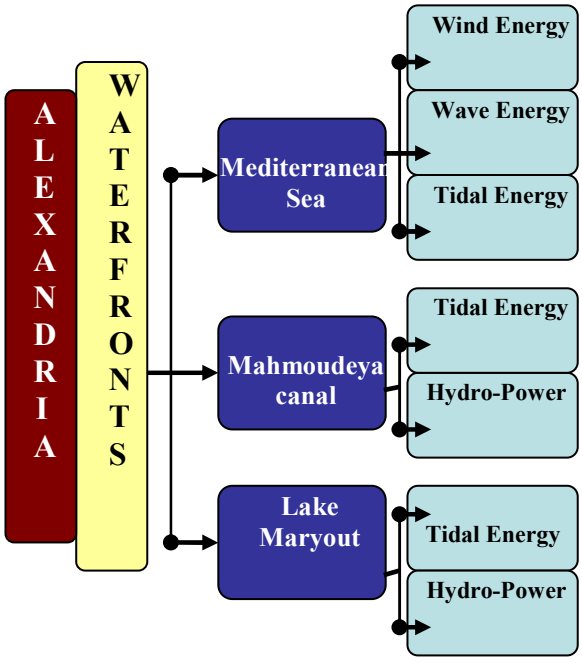

Figure 7: Diagram shows the different renewable sources that can be implemented on Alexandria's waterfront

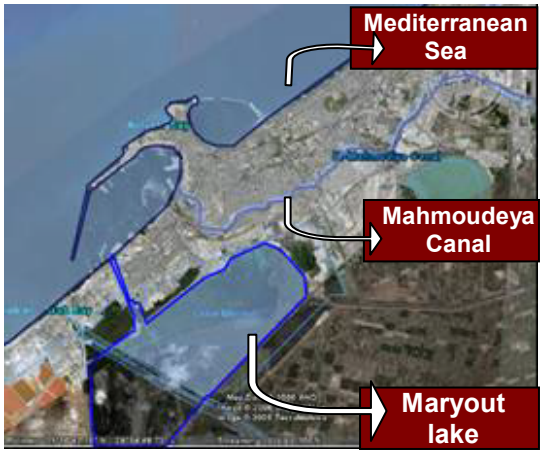

Figure 8: Shows the allocation of the 3 main renewable water energy sources in Alexandria

4.1 Mediterranean Sea

The Mediterranean Sea on Alexandria coast is split into 2 areas the eastern harbor and the western harbor. Both harbors are of different functions. The eastern harbor's main movement is fishing boats while the western harbor has more movement than that of the eastern harbor. This stops the creation of any renewable energy systems on the western side as not to obstruct the boat traffic movement. Therefore the eastern harbor is preferably used for the implementation of the renewable technology. On the Mediterranean Sea wind energy, wave energy and tidal power can be used in different locations (Fig. 7).

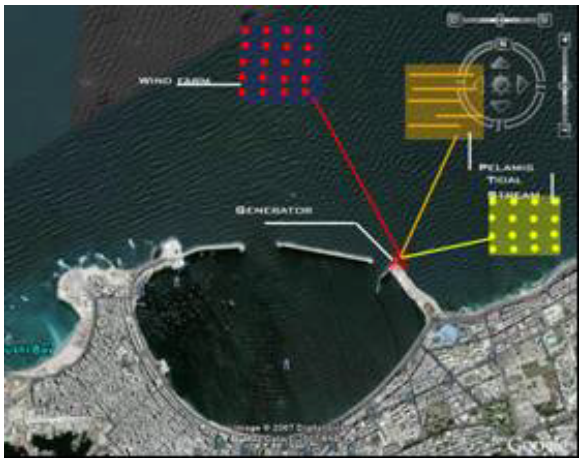

Figure 9 shows were each kind of energy proposed in this area could be placed and proposed position of the generator

4.2 Mahmoudeya Canal

The Mahmoudeya Canal is narrow areas of water were people live with industrial factories in the area. This is one of the areas were people are starting to face problems of the pollution emitted via the factories. This area as proposed in Fig. 7 could have two kinds of renewable energy supply; Tidal and Hydro electric. If these renewable techniques are implemented on the canal these factories could find other sources of clean energy to run their factory rather than using petrol or coal.

Figure 10 Shows the proposed positions of turbines and tidal streams in the Mahmoudeya canal

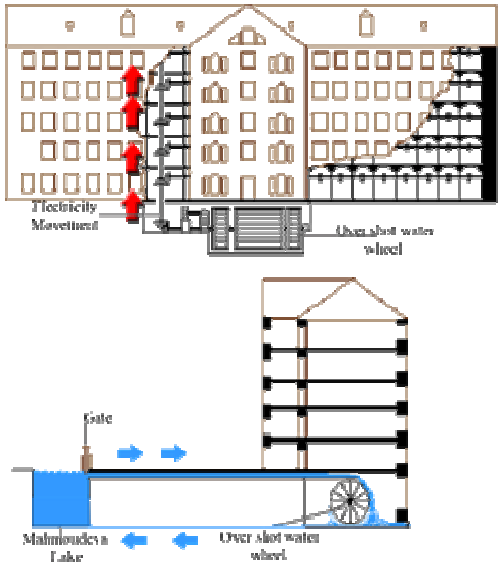

Figure 11 shows how building can power them-selves using water.

This turbine produces 50 Watts. Its dimensions are about 2.00 meters by 1.00 meter. The width of the canal is about 8 meters thereby having 4 turbines in a row creating a total amount of energy per row 200 watts. (9) The turbine could be connected to buildings as shown in Fig. 14.

This could be a good proposal to be used in factories to try to reduce Carbon dioxide emission. In areas were factories will have the over shot wheel turbine built under them, soil needs to be tested to see its feasibility to be added to such buildings.

5. CONCLUSION

As Egypt has already been facing some of the irregular weather patterns, therefore, a reduce in the green house gases emitted should be taken into consideration. Alexandria has a huge waterfront with a lot of potential that is not used to its full capacity such as huge waves, unused land, strong wind movements, strong currents. If these potentials are properly realized as renewable resources, Alexandria will have ample continuous inflow of clean energy, at relatively low costs. The inflow of such energy will be the key to entering Alexandria into the sustainable and renewable energy era. Energy generated into electricity will enable the desalination of sea water into drinkable water, and the energy produced be used in electricity and by factories.

There are many water renewable energy resources however they all have their benefits and problems. What we should look at is how the benefit ways the drawbacks and check whether it is worth while to have such projects in our developing cities considering their long term benefits.

Start forcing factories using renewable energy resources and prohibiting burning petrol and oil in the center of our cities, which produce pollution and increase the greenhouse effect. Finally, creating an applicable 5 year plan to improve the environment where sustainability is taken into account is a crucial development criterion for a Mediterranean city like Alexandria. Building codes and regulations have to be changed and strictly set to encourage renewable energy usage especially for industry and commercial activities. Egyptian government have to reduce fuel and petrol subsidy in order to direct more of the industry into renewable energy usage on one hand and on the other encourage the renewable energy market.

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